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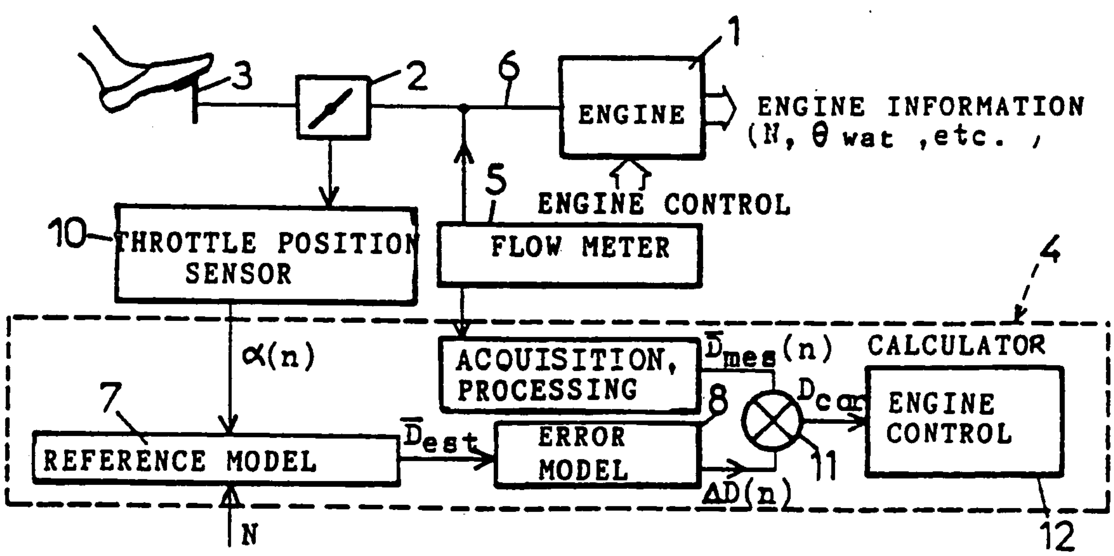
(54) Title: METHOD AND DEVICE FOR EVALUATING THE FLOW RATE OF AIR ADMITTED INTO AN INTERNAL COMBUSTION ENGINE, IN THE TRANSIENT REGIME



(57) Abstract

A measurement $\overline{D}_{mes}(n)$ is made, with the aid of a flow meter (5), of the flow rate of air admitted, an estimated air flow rate $\overline{D}_{est}(n)$ is extracted from a reference model (7) and an additive correction term $\Delta\overline{D}(n)$ of the measurement $\overline{D}_{mes}(n)$ is extracted from an error model (8) controlled through the estimated air flow rate $\overline{D}_{est}(n)$. The input variables of the reference model are the angle of opening (α) of a throttle for regulating the air flow rate and the speed (N) of the engine. Application to a device for controlling the richness of the air/fuel mixture supplying an internal combustion engine propelling a motor vehicle.

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Method and d vice for evaluating the flow rate of air admitted into an internal combustion engine, in the transient regime.

The present invention relates to a method and a device for evaluating the flow rate of air entering an internal combustion engine fitted with an electronic injection system and, more particularly, to such a method and such a device enabling this air flow rate to be accurately evaluated during transient phases of operation of the engine, such as a sudden acceleration or a sudden deceleration.

The driver of a motor vehicle propelled by an internal combustion engine varies the speed of the vehicle by acting upon an accelerator pedal which conventionally is mechanically coupled to a throttle for regulating the flow rate of air admitted into the engine. The latter then varies instantaneously whereas the quantity of petrol injected is modified only after some delay so as to match up with the air/fuel ratio corresponding to the stoichiometry. This results, in the transient regime, in a deviation in this ratio relative to the stoichiometry. In modern vehicles fitted with antipollution devices consisting of a "catalytic" silencer, this deviation is particularly troublesome since such a silencer is designed to operate with an engine supplied with an air/fuel mixture as strictly stoichiometric as possible.

To attempt to reduce this deviation, it is necessary, on the one hand, to make available means permitting accurate knowledge of the flow rate of air admitted into the engine in the transient regime, at any instant, and on the other hand, bring it about that the quantity of petrol provided to the air/fuel mixture then follows, without delay, the variations in the flow rate of air admitted.

To instantaneously evaluate the flow rate of air entering an engine, a method is known based on the assumption according to which this flow rate is proportional to the product of a measurement of the angular opening α of the throttle (regarded as a variable load loss) times the speed of rotation of the engine (regarded as a pump whose intake pressure depends on the rate of

rotation). This method is rapid since it is bas d on the causes of variation of the flow rate but it is also very inaccurate (in particular, the air pressure varies with altitude) and can only be implemented in bottom-of-the-range injection devices for which the performance standards and the antipollution standards are the least demanding. Furthermore, this method is not adaptive and the results may thus be affected by the fouling of the inlet assembly of the engine, including the air filter.

Means of direct measurement of the air mass flow rate are also known, such as vane or hot-wire flow meters which, associated with other sensors, enable the flow rate of air admitted into the engine to be evaluated with good accuracy.

These measurement means have however the disadvantage of introducing substantial time delays. With vane flow meters, these delays are due to time constants of mechanical origin and to information processing times. With hot-wire flow meters, the delays result from a necessary filtering of the signal delivered (this signal being strongly pulsed and affected by overshoot at times of transitions) as well as from information processing time. These time constants delay the measurement relative to the actual variation in the flow rate, this delay possibly reaching several "engine" revolutions.

In order to limit these delays, the document EP-A-115 868 describes a method of controlling the fuel supply of an internal combustion engine, according to which the quantity of air entering the engine is evaluated beforehand with the aid of samples of a signal provided by an air flow meter, of a dynamic model of the entry of air into the engine and of recursive calculations on the quantities of air calculated based on an assumption of linear variation between two samples of this quantity. This m th d is th r for based on calculated quantiti s of air which are available only after a delay. Furthermor , the assumption of linear variation g nerat s inaccuracy in the event of sudden variations (with high gradient), as is often the case in

the transient r gime.

The pres nt invention ther fore aims to provide a m thod and a device nabling, in the transient r gime, the flow rate of air entering an internal combustion engine to be evaluated, and which do not have the abovementioned disadvantages of the methods and devices of the prior art, and which consequently ensure rapid and accurate evaluation of this air flow rate.

The present invention also aims to provide such a method and such a device which are autoadaptive.

These aims of the invention are achieved, as well as others which will emerge in the remainder of the present description, with a method of evaluating the flow rate of air entering an internal combustion engine when the latter operates in a transient regime, according to which a measurement is made of this flow rate, and this measurement is corrected with an additive correction term. According to the invention, an estimated air flow rate is extracted from a reference model of this flow rate and the additive correction term is extracted from an error model controlled through the estimated air flow rate.

According to a mode of implementing the method according to the invention, the input variables of the reference model are the angle of opening of a throttle for controlling the flow rate of air admitted and the speed of the engine. Such a reference model permits a rapid estimation of the flow rate of air admitted and therefore no less rapid availability of the additive correction term provided by the error model.

According to a variant of the method according to the invention, parameters of the reference model are corrected as a function of the observed deviation, in the steady regime, between the measured and estimated air flow rat s. This ensur s the autoadaptivity of th method and of the device according to the invention.

In order to implem nt the method according to the invention, the invention provides a device comprising a sensor of flow rat of air ntering th engine and means

supplied with the output signal from this sensor in order to calculate an additiv correction term of the flow rate measured by the sensor in such a way as to accurately evaluate the flow rate of air entering the engine. According to the invention, the calculation means comprise means for storing and implementing a model for calculating a reference air flow rate and an error model controlled through the output from the reference air flow rate model in order to provide a correction term and means for adding this correction term to the measured flow rate, this sum representing the flow rate of air actually entering the engine in the transient regime.

According to a preferred embodiment of the device according to the invention, the latter further comprises a sensor of position of a throttle for controlling the flow rate of air admitted, a sensor of speed of the engine, and means of inputting the signals delivered by these sensors into the reference model in order to calculate the estimated air flow rate.

According to a variant, the calculation means of the device according to the invention further comprise means responsive to a deviation observed, in the steady regime, between the measured and estimated air flow rates in order to backwards-correct parameters for regulating the reference model.

Other features and advantages of the method and of the device according to the invention will emerge on reading the following description and on examining the attached drawing in which:

- Figure 1 represents a set of graphs useful in understanding the method according to the invention,
- Figure 2 is a block diagram of a device for implementing the method according to the invention, and
- Figure 3 is a block diagram of one part of a variant f th device according to the invention, ensuring an aut adaptation of the reference model used in this d vic .

Referenc is made to Figur 1 of the attach d drawing in which th graphs 1 and 2 r present

r sp ctively the chang in the opening $\alpha(n)$ of the throttl valve of an int rnal combustion engin and of the speed $N(n)$ of this engine in a transi nt phase of operation of this engine corresponding, by way of non-limiting example, to a sudden acceleration. The instants n-1, n, n+1, ... etc. are sampling instants of measurements made by sensors of throttle angle and of speed of the engine. In an internal combustion engine, these sampling instants may correspond to the instants of passage of the pistons to the top dead centre, as is conventional in digital devices for controlling fuel injection and/or ignition. The graph 3 represents the average quantity of air $\bar{D}(n)$ actually entering the engine. Generally in what follows, the symbol $\bar{D}$ designates an average air flow rate, filtered of disturbing fluctuations. The graph 4 represents the flow rate of air $\bar{D}_{mes}(n)$ admitted into the engine, as deduced from a signal delivered by a hot-wire or hot-film air flow meter for example. From comparing the graphs 3 and 4, it appears that the air flow rate thus measured by virtue of the flow meter (graph 4) changes parallel to the true flow rate $\bar{D}(n)$ (graph 3) but with a delay due, as seen above, to the filtering and to the times for acquiring and processing the signals provided by the flow meter. In the example represented, the case has been chosen of a four-cylinder, four-stroke engine for which the sampling period (1/4 of the engine cycle) corresponds to a half-revolution of the transmission shaft (or 1/2 "engine" revolution). As illustrated, the flow rate measurement provided by the flow meter may conventionally suffer a delay greater than 1 engine revolution. It is the aim of the present invention to substantially reduce the significance of this delay, so as to make the latter less than the sampling period for the parameters of the system, namely a 1/2 engine r volution. From a more instantaneous and mor accurat knowl dg thereby obtained of th flow rat of air admitted, it is then possible to regulate the quantity of petrol injected into the engine so as to conform to the stoichiometry in a

more constant mann r than is possible with the means of th prior art. Advantageously, b tter adjustment to the operating requirements of "catalytic" silencers and better driving comfort are extracted therefrom.

According to the invention, in order to achieve these results, use is made of a reference model providing an estimate $\bar{D}_{est}$ (n) of the flow rate of air admitted. According a mode of implementation of the method according to the invention, this model takes the form:

$$\bar{D}_{est}(n) = f(\alpha(n), N(n))$$

As seen above in the preamble of the present description, such a model is in fact able to provide an estimate of the flow rate of air admitted. It will be noted that the graph 5 ($\bar{D}_{est}(n)$) is thus extracted from the samples of $\alpha(n)$ and $N(n)$ appearing in graphs 1 and 2. This model very closely follows over time the variation in the true flow rate, by virtue in particular of the parameter $\alpha(n)$, changes in which are rapid.

According to an essential feature of the method according to the invention, use is made of an error model controlled through the estimated flow rate $\bar{D}_{est}(n)$ in order to extract (see graph 7) a correction term $\Delta\bar{D}(n)$ which, added to the measured flow rate $\bar{D}_{mes}(n)$, represents the corrected flow rate $\bar{D}_{cor}$ (graph 6), this graph corresponding to the addition of graphs 4 and 7.

By virtue of the rapid estimate of the flow rate and of the error model which are used in the invention, the corrected flow rate $\bar{D}_{cor}$ (graph 6) is very near the true flow rate (graph 4), the delay affecting it being in particular considerably reduced (less than 1/2 engine revolution) relative to the delay of the measurement $\bar{D}_{mes}(n)$ with respect to the true flow rate $\bar{D}(n)$.

The invention is thus essentially based on the use of two models, a reference model describing the behaviour of the inl t assembly of the engine, and an error model.

The reference model set out above is given m rely by way of xample. More generally, this reference model may b expressed in the form:

$\bar{D}_{est}(n) = f[\alpha(n), N(n), etc...)$

Parameters such as th temperatur and the pressure of the atmospheric air may b taken into account, as well as the angle of opening of the throttle and the speed of the engine. The model is established from bench measurements made on the engine. It will be possible to use a dynamic model of the behaviour of the inlet assembly. As a variant, this behaviour could be recorded in a table comprising for example two inputs (engine speed, throttle angle) and one output (estimated air flow rate). Between two bench-tested operating points, the table is traversed by linear interpolation, for example.

The estimate $\bar{D}_{est}(n)$ thus obtained of the mass of air entering the engine is used to calculate the change, at any instant within the transient phases of operation of the engine, in the error distancing the measurement $\bar{D}_{mes}(n)$ from the flow rate of air actually admitted into the engine at this instant. This calculation is carried out with the aid of an error model, one of the possible expressions of which will be given below by way of example. The estimate of the error takes into account, on the one hand, the existence of a pure delay between a measured value and a true value, due to the acquisition system and, on the other hand, the filtering exerted by the inlet assembly on the mass of incoming air, owing to a capacitive effect developed within this assembly.

Generally, the error model can be expressed in the form:

$$\Delta\bar{D}(n) = F[\Delta\bar{D}(n-1), \bar{D}_{est}(n), \bar{D}_{est}(n-1), N(n)]$$

which expresses the fact that the error in the quantity of air admitted at the instant n is a function of the error in the quantity of air at the instant (n-1), of the quantity of air estimated at the instant n and (n-1) and of the engin sp d at th instant n. The expression for th error could possibly take acc unt of other paramet rs such as th temperatur of the inl t air for example.

By way of non-limiting xample, a usable error model can tak the following form:

$$\Delta\bar{D}(n)=\Delta\bar{D}(n-1)+\frac{\Delta T}{\tau'}N(n)[\bar{D}_{est}(n)-\bar{D}_{est}(n-1)]-\frac{dt}{\tau'}N(n)]\Delta\bar{D}(n-1),$$

where

τ' is a time constant dependent on the characteristics of the inlet assembly (capacity, etc.) and

ΔT is the error estimation horizon, equal to an integer number of sampling periods dt, for example three periods.

The final estimate of the average flow rate of air entering the engine at the instant n is obtained by taking the sum of the measured average flow rate and of the error in the average flow rate, namely:

$$\bar{D}_{cor}(n) = \bar{D}_{mes}(n) + \Delta\bar{D}(n).$$

Reference is now made to Figure 2 of the attached drawing in which a block diagram has been represented of a device for implementing the method according to the invention. The admission of air into an engine 1 is regulated by a throttle valve 2 whose angular position is controlled by the driver of a motor vehicle, by means of an accelerator pedal 3. The engine 1 receives control signals from a calculator 4 (injection time, instant of ignition, etc.) and delivers, via appropriate sensors, measurement information relating to its operation (engine speed N, cooling water temperature θ_{wat}, etc.). A flow meter 5 measures the air flow rate in the inlet assembly 6 of the engine. The calculator comprises means of acquiring and processing this measurement, which deliver the signal $\bar{D}_{mes}(n)$ affected by a significant delay which may be several "engine" revolutions for example, as seen above. According to the invention, this delay is corrected with the aid of a reference model 7 and of an error model 8 which are recorded in appropriate memory means provided in the calculator 4. The reference model is supplied with a signal $\alpha(n)$ originating from a throttl p sition sensor 10 and with a signal N riginating from an engin speed s nsor (not shown), such as an electromagnetic reluctance sensor for example. The reference model calculates an estimated air flow rat $\bar{D}_{est}$

which controls the error model 8. The latter delivers a correction signal $\Delta\bar{D}(n)$ which is combined with the signal $\bar{D}_{mes}(n)$ in an adder 11 in ord r to provid a signal $\bar{D}_{cor}$ representing the flow rate of air actually admitted into the engine. This signal supplies calculation and control means 12 which formulate in particular, from the air flow rate thus known, the quantity of petrol to be injected into each of the cylinders of the engine so as to conform to the stoichiometry of the air/fuel mixture during the transient phases of operation of the engine. Outside of these transient phases, these means 12 calculate in a conventional manner the quantity of petrol to be injected into the engine, in order to ensure the stoichiometry of the air/fuel mixture.

One part of the block diagram of a variant of the device of Figure 2, enabling a characteristic of auto-adaptivity to be imparted to the latter, has been represented in Figure 3.

It is observed in fact that the various parameters characterising the engine are able to change in the course of time. The value of the estimated flow rate calculated by virtue of the reference model may eventually deviate from the true value, owing to fouling of the air filter, fouling of the valves, wear to the cams, etc.. Other phenomena may affect the validity of the reference model, a variation in atmospheric pressure due to a variation in altitude for example.

According to the invention, use is made of a matching algorithm 13 enabling the values of the parameters used in the reference model to be corrected in order to preserve the accuracy of the estimate. This algorithm is brought into play in steady phases of operation of the engine during which, at given throttle opening and given engine speed, the values of the measured average air flow rate $\bar{D}_{mes}$ and of the estimated fl w rate $\bar{D}_{est}$ are c mpared. Th values of the various param ters (a_i) coming into the refer nc model are corr cted, as a functi n of th deviation observ d, with the aid of an algorithm of the form:

$$a_{i1} = a_{i0} + \alpha \delta a_i$$

wh re a_i = ith param ter of th r f rence model,

δa_i = value of th correction, and

α = weighing coefficient (α<<1).

As seen above, the value of the correction δa_i is a function of the measured flow rate and of the estimated flow rate, for an angle of opening of the throttle, an engine speed and, possibly, an air temperature which are given. The weighing coefficient may consist of a certain percentage of the derivative of the parameter taken into account.

It is now apparent that the present invention enables the sought-after aims to be achieved. By virtue of the use of an error model controlled through a rapid estimate of the flow rate of air admitted, it is possible to provide the fuel injection time calculator with a rapid and accurate instantaneous evaluation of the flow rate of air admitted, which permits adjustment without delay of the stoichiometry of the air/fuel mixture supplying the engine, required for driving comfort and for correct operation of the antipollution devices based upon catalysis of certain exhaust gases.

CLAIMS

1. Method of evaluating the flow rat of air admitted into an internal combustion engine when the latter operates in a transient regime, according to which a measurement $\bar{D}_{mes}(n)$ is made of this flow rate, and this measurement is corrected with an additive correction term $\Delta\bar{D}(n)$, characterised in that an estimated air flow rate $(\bar{D}_{est}(n))$ is extracted from a reference model of this flow rate and the additive correction term $\Delta\bar{D}(n)$ is extracted from an error model controlled through the estimated air flow rate $\bar{D}_{est}(n)$.

2. Method according to Claim 1, characterised in that the input variables of the reference model are the angle of opening (α) of a throttle for controlling the air flow rate and the speed (N) of the engine.

3. Method according to either one of Claims 1 or 2, characterised in that the error model is of the form:

$$\Delta\bar{D}(n) = F\,[\Delta\bar{D}(n-1),\ \bar{D}_{est}(n),\ \bar{D}_{est}(n-1),\ N(n)]$$

where (n-1) and (n) are two successive sampling instants.

4. Method according to Claim 3, characterised in that the error model is of the form:

$$\Delta\bar{D}(n)=\Delta\bar{D}(n-1)+\frac{\Delta T}{\tau'}N(n)[\bar{D}_{est}(n)-\bar{D}_{est}(n-1)]-\frac{dt}{\tau'}N(n)\Delta\bar{D}(n-1)$$

where dt is the sampling period, τ' a time constant dependent on the air admission characteristics of the engine and ΔT the error estimation horizon.

5. Method according to any one of Claims 1 to 4, characterised in that parameters of the reference model are corrected as a function of the observed deviation, in the steady regime, between the measured $(\bar{D}_{mes}(n))$ and estimated $(\bar{D}_{est}(n))$ air flow rates.

6. Method according to Claim 5, characterised in that an updated value (a_{i1}) of a parameter of the reference model is extracted from the relationship:

$$a_{i1} = a_{i0} + \alpha\delta a_i$$

where a_{i0} is th prec ding value of th relevant param - t r, δa_i, th value of a correction term for this parameter, and which is xtracted from th observed d viation,

in th transient regim , betw n the measured and stimated air flow rates, α, a weighting coeffici nt.

7. Method according to Claim 6, charact ris d in that the correction δa_i of the parameter depends on the angle of opening of the throttle, on the engine speed and on the temperature of the air.

8. Method according to either one of Claims 6 and 7, characterised in that the weighting coefficient α consists of a predetermined percentage of the derivative of the parameter (a_i).

9. Method according to Claim 8, characterised in that the weighting coefficient α is such that $\alpha \ll 1$.

10. Device for implementing the method according to Claim 1, of the type which comprises a sensor of the flow rate of air admitted into the engine and means supplied with the output signal from this sensor in order to calculate an additive correction term $\Delta\bar{D}(n)$ of the flow rate $\bar{D}_{mes}$ (n) measured by the sensor, characterised in that the calculation means comprise means for storing and implementing a model for calculating a reference air flow rate and an error model controlled through the output $\bar{D}_{est}$ (n) from the reference air flow rate model in order to provide a correction term $\Delta\bar{D}(n)$ and means for adding the term $\Delta\bar{D}(n)$ to the measured flow rate $\bar{D}_{mes}(n)$, this sum representing the flow rate of air actually entering the engine in the transient regime.

11. Device according to Claim 10, characterised in that it comprises a sensor of position of a throttle for controlling the flow rate of air admitted, a sensor of speed of the engine, and means of inputting the signals delivered by these sensors into the reference model in order to calculate the estimated air flow rate $\bar{D}_{est}(n)$.

12. Device according to Claim 11, characterised in that the calculation means comprise means responsive to a deviation observed, in the st ady regime, b tween th measured $\bar{D}_{mes}(n)$ and estimat d $\bar{D}_{est}(n)$ air flow rates in ord r to backwards-correct param t rs for regulating th ref r nce model.

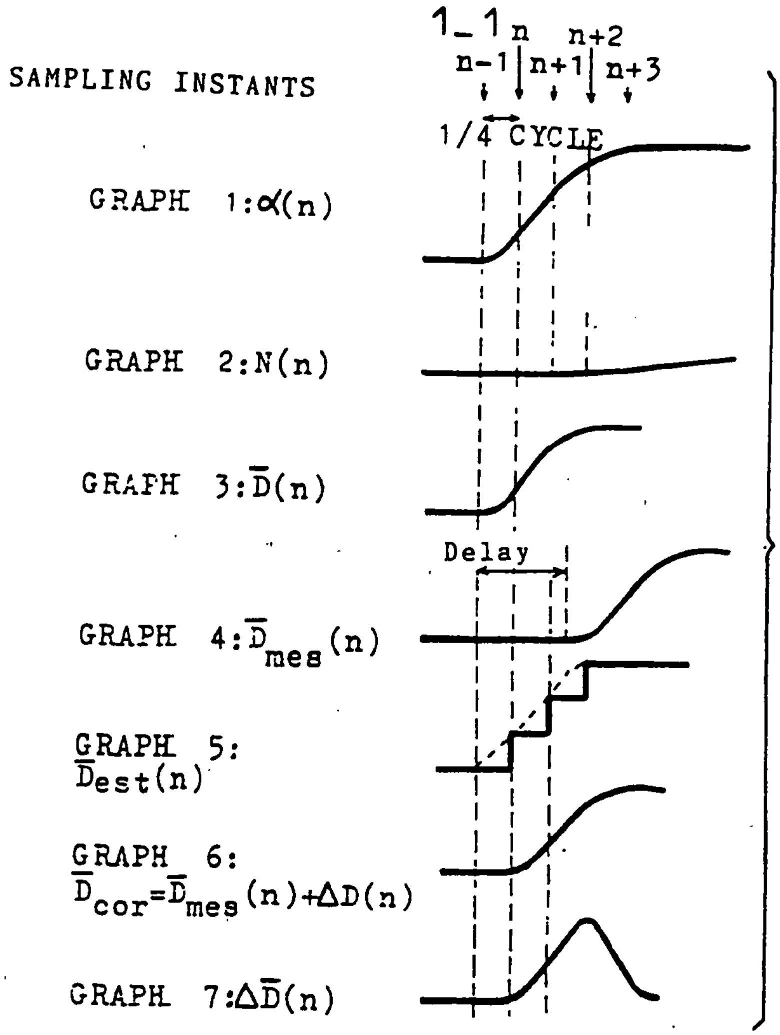


FIG.:1

FIG.:2

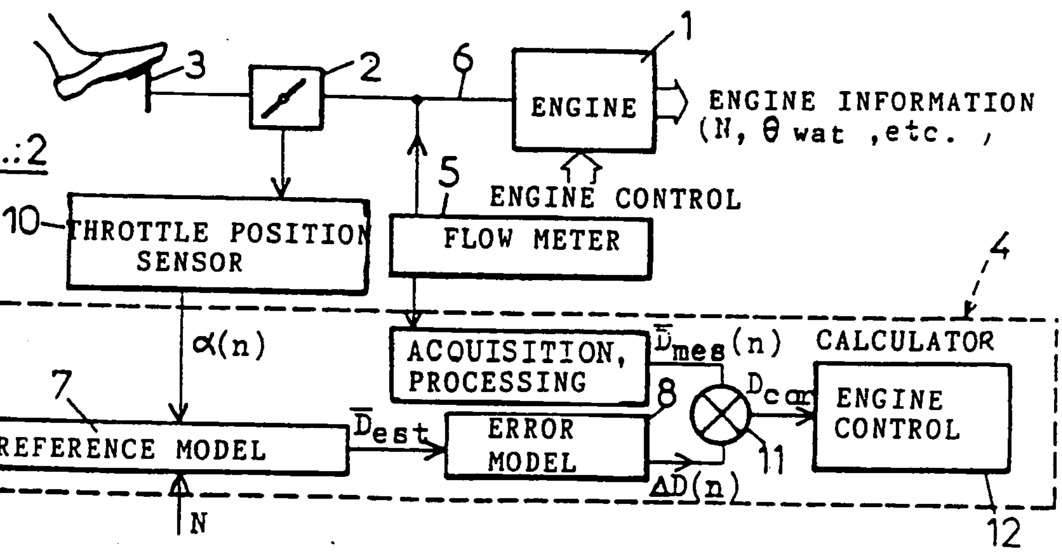
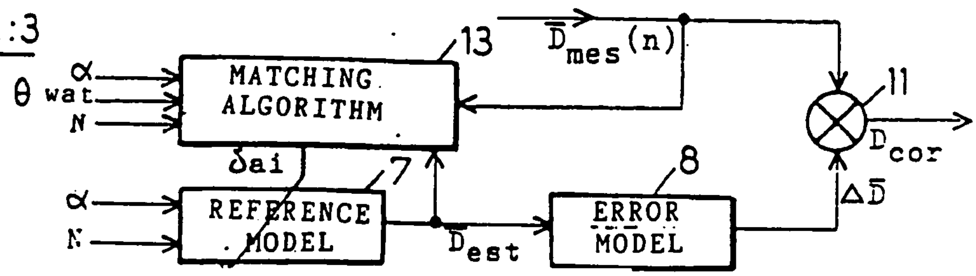


FIG.:3



INTERNATIONAL SEARCH REPORT

International Application No PCT/EP 92/00154

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 F02D41/04; F02D41/10

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	F02D

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category °	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No.[13]
X	EP,A,0 365 003 (HITACHI) 25 April 1990 see claims 1-4,12 ---	1-4,10, 11
X	PATENT ABSTRACTS OF JAPAN vol. 12, no. 227 (M-713)(3074) 28 June 1988 & JP,A,63 021 351 (NISSAN) 28 January 1988 see abstract ---	1,10
A	DE,A,3 919 448 (TOYOTA) 21 December 1989 see claims 1-5 ---	1-4,10, 11
A	PATENT ABSTRACTS OF JAPAN vol. 13, no. 573 (M-909)(3921) 26 September 1989 & JP,A,01 240 753 (FUJI) 18 March 1988 see abstract ---	5,6,12

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
27 FEBRUARY 1992	06. 03. 92
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ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. EP 9200154 SA 55431

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
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Patent document cited in search report	Publication date	Patent family member(s)		Publication date
EP-A-0365003	25-04-90	JP-A-	2108834	20-04-90
		JP-A-	2155072	14-06-90
DE-A-3919448	21-12-89	JP-A-	1315635	20-12-89
		JP-A-	2042160	13-02-90
		US-A-	5003950	02-04-91
		US-A-	5069184	03-12-91

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